Working with Component Based Loss Factors

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FOLSOM LABS

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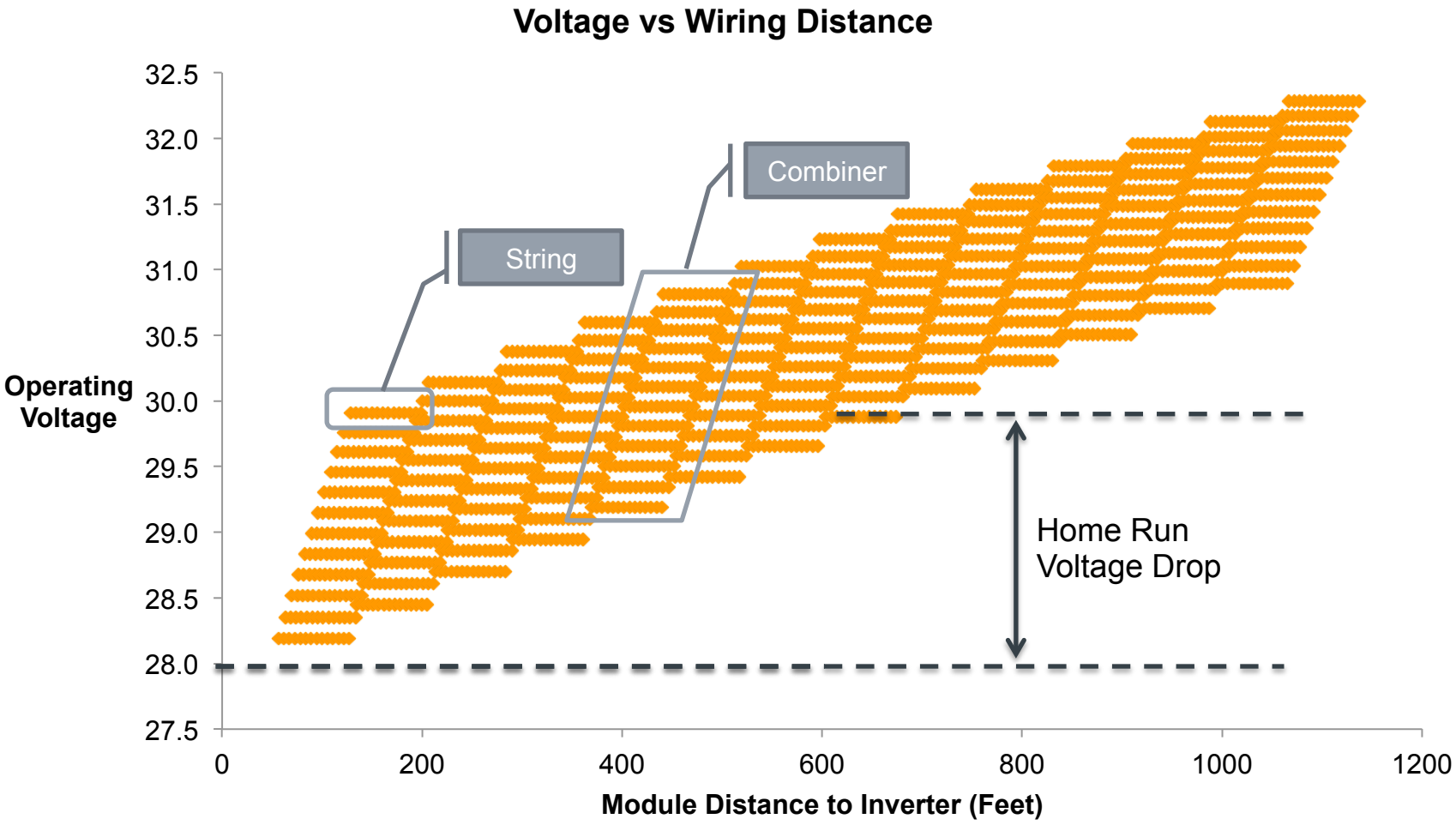
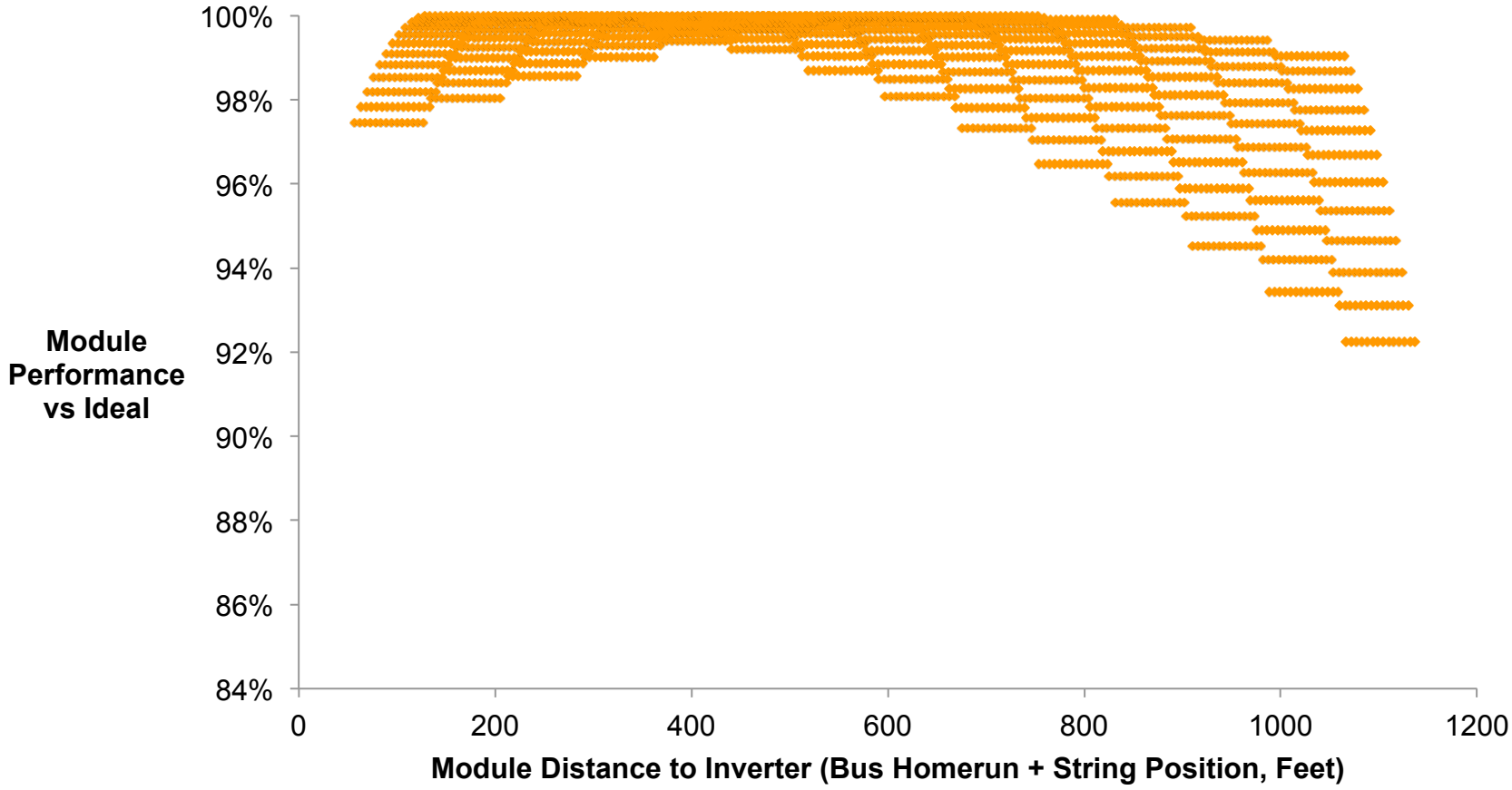
Component level modeling enables a rigorous evaluation of the loss-tree

- Component Level Modeling
- Line Losses
  - Granularity
  - Value Component-level Modeling
- Module Level Electronics
  - Principles of Operation
  - Implications for Modeling

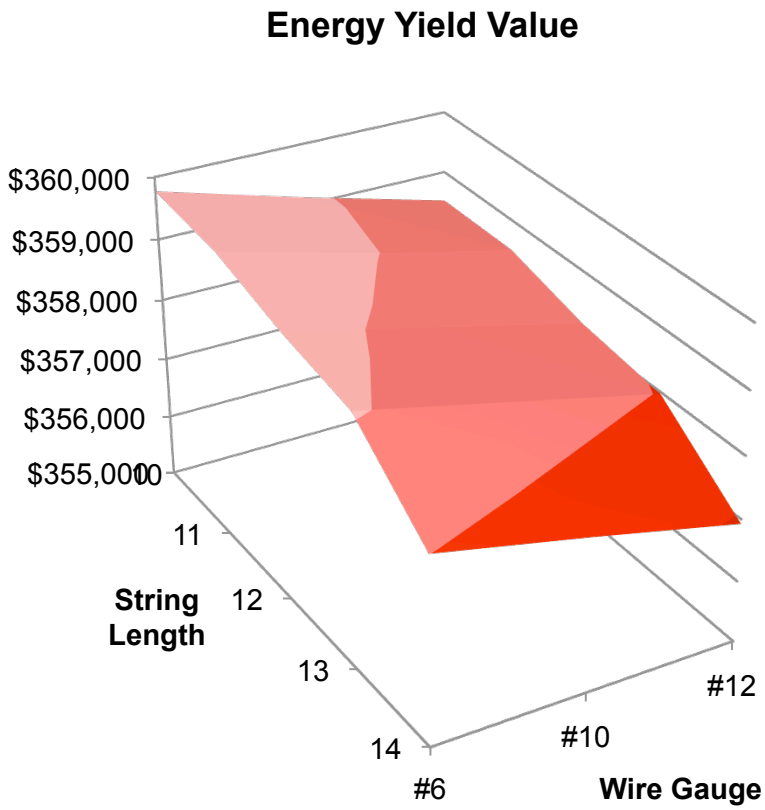
Voltage drops throughout the array affect all upstream components

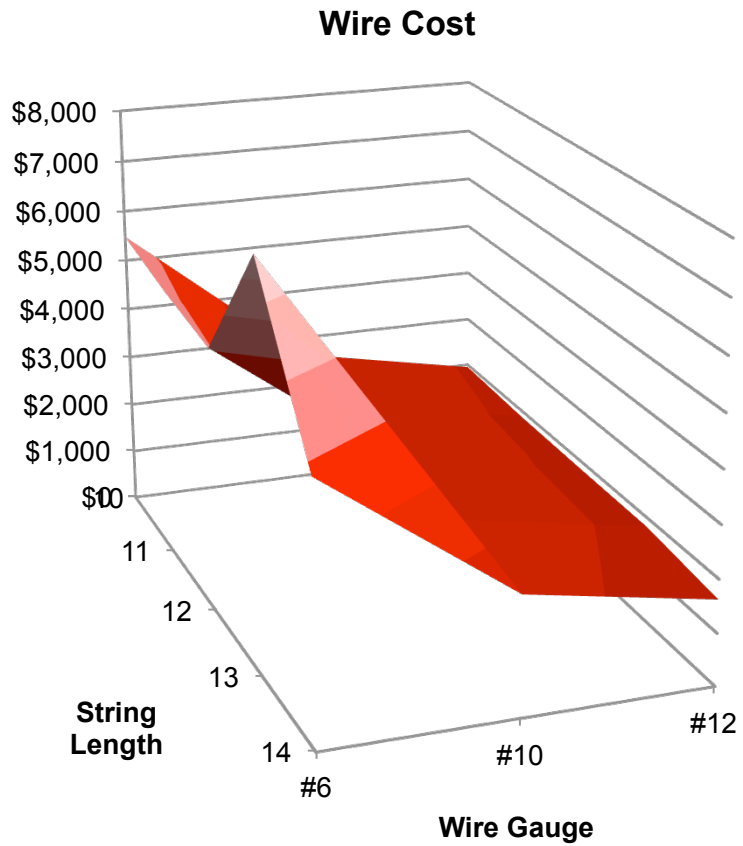


Wiring losses can also be influenced by mismatch effects



This information can be leveraged to optimize the choice of conductor sizing





But what about MPPT Granularity?

- Component based modeling is ideal for modeling the impact of string inverters or module level electronics
- Each has it's own principles of operation, but no standardized way to document and measure performance
  - We have worked with manufacturers individually
- This effects how the entire system runs, and potentially the array architecture

Each piece of electronics has its own principle of operations

	Tigo	Ampt	eIQ	String Inverter
Architecture	Buck Only	Buck-Boost	Boost Only	Inversion
Modeling Example	• How to handle 'flat' portions of transformed output • Hardware relies on proprietary 'controller' algorithm	• Iterative process required in calculation of transitional points	• Inverters Relationship with Inverter • Current accumulates in bus	• Requires detailed AC Subsystem • How to maximize MPPT performance
Considerations	• Simplified hardware • Reduced optimization scope	• Increased scope of optimization • more SKUs • More module-level 'work'	• Significant module activity • design benefits • Component complexity	• No MPPT granularity • Failure rates?

Decreasing 'Effort' ⟷ Increasing 'Effort'

Module level electronics enable specific design optimization

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Implications of Modeling Optimizers Independently

- There is no free lunch…
  - if there isn't mismatch, the optimizer can't help
  - need better physical mismatch models
- … but accurate models bring bankable results
  - Can now assess the benefits of MPPT granularity
  - Central vs. String Inverters vs. distributed MPPT
- Rules of thumb for handling shading must change
- Need public standards for measuring and modeling optimizer efficiency
  - Currently use Voltage Boost Ratio and Power

We look forward to working with the community to improve PV models

Research Interests

- Standardized Performance characterization for module electronics
- Improved Inverter Models
- Updated wiring models?

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